brought from Japan by their intelligent collector Mr. C. Maries.

M. Carrière states, in an editorial note to Count Castillon's article, that the plant had been introduced into France at that date, and was indeed actually on sale in the nurseries near Antibes.

Nothing, however, till quite recently, appears to have been known as to the existence of the square bamboo in China, from which country, however, it is extremely probable that the Japanese procured it. Thus, Mr. F. B. Forbes, whose personal knowledge of the Chinese flora is only second, perhaps, to that of Dr. Hance, informs me:—"I have never seen the square bamboo growing, and I have always supposed that its 'squarity' was artificially produced."

The first authentic account of its occurrence in China is, as far as I know, due to Mr. Frederick S. A. Bourne, of H.B.M. Chinese Consular Service. Mr. Bourne wrote to us, October 15, 1882, that he had made a journey from Foochow to a distance of 300 miles to the western border of the Fokien province, reaching Wu-i-kung, the celebrated monastery in the Bohea hills—a place, Mr. Bourne states, "only visited by a European once before, I believe—*i.e.* by Mr. Fortune, about the year 1845." In the gardens of this monastery he found several clumps of the square bamboo growing to the height of about eight feet.

The *Tropical Agriculturist* (an astonishing repertory of everything relating to the economic botany of the East) contains in its issue for November, 1882 (p. 445), an article extracted from the *North China Herald*, also relating to the square bamboo, plants of which, destined for the park at San Francisco, had been obtained by Dr. Macgowan at Wenchow. I extract from this article the following particulars, which show the interest the Chinese themselves attach to the plant:—

"Pre-eminence is assigned to the square variety of this most useful as well as ornamental plant, which has been a favourite in Imperial gardens whenever its acclimatisation has been effected in the north. The Emperor Kao Tsu once inquired of his attendants, who were planting bamboos, concerning the various kinds. In reply he was informed concerning several remarkable species. Chekiang in particular furnished one that was an extraordinary curiosity, in that it was square, and for that quality and its perfect uprightness was much esteemed by officers and scholars. They also told him that it was used for many purposes of decoration and utility, including, among others, that of being made into ink-slabs. Subsequently specimens were obtained, polished, and sent to his majesty, who thereon signified his respect for the article by rubbing ink with his own hand on the inkstand, and inditing an essay on the curiosity. In 650 A.D. the reigning Emperor sent a eunuch to Chekiang to obtain specimens for the Imperial Park. Besides being furnished from scattered portions of this province, it is found in Honan, Szechuen, Yunnan and Hunan; in the latter province it appears to present its peculiar characteristic in a marked degree, being as square, with corners, and as well defined as if cut with a knife. The Chekiang varieties have slightly rounded corners, and moreover they are more slender, being used only as pipe-stems, whereas the western kind is large enough to serve as staves for the aged. In its early stage of growth the square bamboo is nearly round, assuming the anomalous figure it afterwards presents as it advances towards maturity. Like several other kinds of bamboo it is thorny, abounding in small spines."

Dr. Macgowan being well known to botanists for his intelligent interest in all that relates to the vegetable productions of China, I ventured to write to him to ask his aid in procuring living specimens of this interesting plant for the Royal Gardens. Through his kindness and that of Mr. E. H. Parker, late acting consul at Wenchow, we were fortunate enough to receive a Wardian case filled with plants of the square bamboo, some of which at least appeared to be alive and likely to grow. Besides these Dr. Macgowan sent us specimens of walking-sticks and pipe-stems made from it.

I quote the following passages from the very interesting communication with which Dr. Macgowan was also good enough to favour us:—

"Its geographical range is from 25° to 30° N. latitude, littoral, and westward farther than I have been able to discover. Unlike other varieties of bamboo here, its shoots are developed in the autumn, not in the spring. It sprouts in September or October, and the stems grow until they are arrested by December cold, by which time they attain a height of from two to four or five feet. In the spring following their growth recommences, when the grass attains its full height, ten to fourteen feet. The lower portion of the culms bristle with short spines; in the second or third year their squareness is far less striking than when matured by several years' growth; that quality is sometimes so marked that a native botanist describes them as appearing like rods pared by cutting instruments. I have seldom found the corners much more sharply defined than in the largest of the specimens herewith transmitted. It is cultivated chiefly for ornament in gardens, in temple courts, &c.; the larger stems (sometimes as much as an inch and a half through) are used for staves; the smaller and less squarish for stems of opium-pipes; and the smallest and less mature for tobacco-pipes."

He further adds:—"Its anomalousness is attributed by the Chinese to supernatural powers—occult agencies varying with each district. The *Ningpo Gazetteer* tells how Ko Hung, the most famous of alchemists (fourth century A.D.), thrust his chopsticks (slender bamboo rods pared square) into the ground of the spiritual monastery near that city, which, by thaumaturgical art, he caused to take root and to appear as a new variety of bamboo—square."

As no flowering specimens of the square bamboo have reached the hands of botanists, its taxonomic position must at present be regarded as doubtful. Rivière ("Les Bambous," p. 315) refers to it as the *Bambou carré*, and Fenzi, quoting from Rivière (*Bull. Soc. Tosc. di Ort.*, 1880, p. 401), gives it the name *Bambusa quadrangularis*.

I can discover no reference to it in the late General Munro's classical monograph of the *Bambusaceæ* (*Trans. Lin. Soc.*, vol. xxvi.). Of the three groups into which he divides the genera, in only one, *Triglossæ*, is there any tendency to depart from the habit of the order in having anything but round stems; and this only occurs in the small genus *Phyllostachys*, in which they are somewhat laterally flattened. The stems of *Phyllostachys nigra* are often used in Europe for walking-sticks and light broom-handles.

But I do not think the square bamboo will turn out to be a *Phyllostachys*. Munro has a *Bambusa angulata* which is distinguished from all its allies by having the branches of the panicle angular. This is the only tendency to angularity of stem which I have discovered among the true *Bambuseæ*.

For the present, at any rate, the species must be known provisionally as *Bambusa quadrangularis*, Fenzi.

W. T. THISELTON DYER

FORECASTING BY MEANS OF WEATHER CHARTS

THE Meteorological Office has issued a work on the "Principles of Forecasting by Means of Weather Charts," which has been prepared at the request of the Council by the Hon. Ralph Abercromby.[1] The object of

[1] "Principles of Forecasting by Means of Weather Charts." By the Hon. Ralph Abercromby, F.R.Met.Soc. Issued by the Authority of the Meteorological Council. Official No. 60. 8vo. Pp. 123 + viii. London: 1885.

the author has been to give an account of the modern method of forecasting weather by means of synoptic charts; and although the general principles laid down hold all over the world, the details he gives refer only to Great Britain. The whole system of synoptic forecasting depends entirely on the observed association of different sets of phenomena, and is totally independent of any theory of atmospheric circulation.

The synoptic charts prepared at the Meteorological Office are constructed in the following manner. Every day at 8 A.M. and 6 P.M. telegraphic reports are sent up to London from about fifty stations in the United Kingdom, giving the readings of the barometer and thermometer, the direction and force of the wind, and the state of the weather. These readings are then plotted on a map, and the "isobars" and "isotherms" drawn, representing lines of equal pressure and equal temperature. The isobars are the most important element in forecasting. The direction of the wind is shown by arrows which have a number of "fleches" proportional to the force, while the weather is indicated by the letters of Beaufort's notation. While the force of the wind depends on the closeness, and the direction on the trend, of the isobars, the weather is governed by the shape of the lines. Although the shape of the isobars is continually changing, several well-defined forms are always reproduced. Seven of these are described, to which the following names have been given:—1. Cyclone—an area of low pressure, bounded by circular or oval isobars; 2. Secondary cyclone—a small, circular depression, subsidiary to the cyclone; 3. V-shaped depression—an area of low pressure bounded by V-shaped isobars, something like a secondary, but differing from it in many important particulars; 4. Anticyclone—an area of high pressure bounded by circular or oval isobars; 5. Wedge-shaped isobars—an area of high pressure bounded by isobars converging to a point like a wedge; 6. Straight isobars—a barometric slope, down which the isobars lie in straight lines; and 7. *Col* or neck of low pressure lying between two adjacent anticyclones.

Cyclones.—A cyclone may be of any diameter, from 100 to 3,000 miles. The most common are between 1,000 and 2,000 miles; and anything less than 1,200 miles across is a small one. The path of a cyclone is the path described by the centre. In this country 90 per cent. move towards some point of east, the most frequent direction being about east-north-east. The velocity is that of the centre; it may be anything from 70 miles an hour eastwards to 10 miles an hour westwards. About 20 miles is a common velocity, but sometimes a cyclone is stationary. The life of a cyclone is measured by the number of days during which it can be traced on synoptic charts; the length of life may be anything from a few hours to 20 days. The details of wind, weather, &c., in the different portions of a cyclone may be briefly summarised as follows:—The temperature is always higher in the front than in the rear; the warm air in the front having a peculiar close, muggy character, quite independent of the actual reading of the thermometer. The cold air in the rear, on the contrary, has a peculiarly exhilarating feeling, also quite independent of the thermometer. The front is always very damp, especially the right-front, while the rear is dry to a marked degree. The wind blows around the centre in the direction contrary to the motion of the hands of a watch; but as the direction is slightly inclined to the isobars, on the whole the circulation is an ingoing spiral. The amount of incurvature is usually greatest in the right-front, and least in the rear; so that sometimes the passage of the trough is marked by a sudden shift of wind. The force of the wind depends almost entirely on the gradients; in the centre it is a dead calm, and the steepest gradients are usually found at some distance from the centre. The direction from the centre in which the strongest winds are found depends on the position of the surrounding areas of high pressure.

There is no difference between ordinary weather and a storm, except in that property called *intensity*, and in this country a summer breeze and winter gale are equally the product of cyclones which differ only in intensity. Hence in forecasting storms it is necessary not only to foresee the arrival of a cyclone, but of one possessing sufficient intensity to cause a gale, and in tracking cyclones it by no means follows that the same one causes a storm during every day of its existence. Observation has also shown that a deepening cyclone is increasing in intensity, while one which is filling up is decreasing. When in watching the progress of cyclones by telegraph it is very important for forecasting to note changes in depth, as well as any other indications derived from the configurations of the isobars, or even from weather prognostics, which experience has shown to be associated with intensity.

Though the general characteristics of a cyclone are invariably maintained, still, individual cases vary much in detail. The principal sources of variation which modify, but do not alter, the general characteristics are:—1, the type; 2, the intensity; 3, the size; 4, local; 5, diurnal; and 6, seasonal variation.

Secondaries.—The secondary is a small cyclone formed on the side of a larger one which is called the "primary." Secondaries are almost invariably formed either along the prolongation of the trough of a cyclone, or else on that side of the primary which adjoins the highest adjacent pressure. The most important feature about them is the manner in which they deflect the isobars of the primary, so as to leave an area of slight gradients and light winds on the side of the secondary next the primary, and a line of steeper gradients and stronger winds on the side furthest from the primary. Their motion is usually parallel to that of the primary. The most striking difference between a secondary and a primary cyclone is the great amount of rain and cloud with absence of wind developed in the former, compared with the less rain and cloud but the stronger wind developed in the latter. In a secondary when the rain comes on, it is usually very heavy and falls straight; and in its general appearance and surroundings is very different from the driving or drizzling rain, so characteristic of the front of a primary cyclone. In forecasting, the principal indication of secondaries is rain, without much wind, and thunder-storms in summer; and their sudden formation very often unexpectedly disturbs and vitiates former forecasts. Sometimes several secondaries are seen on the chart; this is a sign of great intensity, and the indication in such cases is always for wild, broken weather, often with thunder-storms, but not for widespread gales.

V-shaped Depressions.—These are generally formed along the southern prolongation of the trough of a cyclone, or in the col or furrow of low-pressure which lies between two adjacent anticyclones. Their motion is generally eastwards along with their associated cyclone, but they are very often short-lived. They are entirely non-cyclonic. The line of the trough, along which the barometer rises, marks out the line along which the weather changes very abruptly, and this change is very often accompanied by a violent squall.

Anticyclones.—Anticyclonic isobars enclose an area of high pressure which is associated with fine weather and light winds circulating in the direction of the hands of a watch, but a little outcurved. The whole system is usually stationary for many days together. The general characteristics are a cold, dry air, and fine, or at least quiet, weather. The calms, or light winds, give free play to the radiation of the season, so that very hot days occur in summer and very cold nights and fog in winter. In forecasting, the indications are for settled fine weather, the details depending much on the season and local peculiarities.

Wedge Isobars.—These consist of isobars converging almost to a point, but enclosing an area of high pressure,

instead of a low one, as in the case of the V's. The wedges seem to shoot up in front of cyclones and V depressions and to travel along before them. On the front, or east side, the weather is very bright, and the wind is north-west and moderate, while the temperature is that due to excessive radiation. On the rear, or west side, where the barometer begins to fall, the wind turns to south-west, and the sky overcasts in that peculiar manner which first gives a halo, and then gradually becomes black, without true cloud as the cyclone approaches. At the extreme north point of the wedge a shower or thunderstorm is sometimes observed.

Straight Isobars.—In these the pressure is high on one side and low on the other, without any definite cyclone, the isobars running straight across the slope which joins the regions of high and low pressure. Straight isobars are never persistent, and the area which they have occupied is usually traversed by a cyclone of greater or less intensity. For forecasting purposes the indications are for cool, cloudy, unsettled weather, the wind from moderate to fresh, according to the gradients, to be followed soon by rain, as a cyclone forms or comes up.

Cols.—The col consists of a neck of low pressure between two anticyclones. The wind is always light and the weather quiet, but variable in appearance, owing to the local influence of radiation. Though the general position is sometimes nearly stationary, the weather is rather variable, owing to the tendency of the depression which lies on the north-west to develop a secondary in the col. Hence in forecasting, though it is possible to tell what the weather would be in the col at any moment, the future course of the weather is subject to much uncertainty.

Mr. Abercromby devotes a considerable portion of his work to a discussion of weather-types and sequence. With reference to Western Europe, there are at least four well-marked types of weather: 1. The Southerly, in which an anticyclone lies to the east or south-east of Great Britain, while cyclones coming in from the Atlantic either beat up against it or pass towards the north-east. 2. The Westerly, in which the tropical belt of anticyclones is found to the south of Great Britain, and the cyclones which are formed in the central Atlantic pass towards the east or north-east. 3. The Northerly, in which the Atlantic anticyclone stretches far to the west and north-west of Great Britain, roughly covering the Atlantic Ocean. In this case cyclones spring up on the north or east side, and either work around the anticyclone to the south-east, or leave it and travel rapidly towards the east. 4. The Easterly, in which an apparently non-tropical anticyclone appears in the north-east of Europe, rarely extending beyond the coast-line, while the Atlantic anticyclone is occasionally totally absent from the Bay of Biscay. The cyclones then either come in from the Atlantic and pass south-east between the Scandinavian and Atlantic anticyclones, or else, their progress being impeded, they are arrested or deflected by the anticyclone in the north-east of Europe. Sometimes they are formed to the south of the north-east anticyclone, and advance slowly towards the east, or, in very rare instances, towards the west.

Mr. Abercromby next explains the use of various aids to forecasting, and gives some detailed examples of successful and unsucessful forecasts.

In concluding his work, Mr. Abercromby gives some remarks on forecasting generally, and points out that in many cases of small disturbances the minor features are so local that it is only the general character of the weather which can ever be forecast. Owing to the rapid nature of all meteorological changes, forecasts can never be issued very long in advance. The British forecaster labours under peculiar difficulties from his geographical position. Situated on the most outlying portion of Europe, and in the very track of storms which almost always advance from the westward, he has no intimation of an approaching cyclone till it is actually on him. Mr. Abercromby's opinion is that, however carefully the relation of weather to isobars may be defined and the nature of their changes described, the judgment which experience alone can give to enable a warning to be issued must ever depend on the professional skill of the forecaster.

RADIANT LIGHT AND HEAT[1]

II.

The Theory of Exchanges

IT was known at a comparatively early period that if a body be placed in an enclosure of constant and uniform temperature, it will ultimately attain the temperature of this enclosure.

To fix our ideas, let us suppose that we have a chamber surrounded on all sides by walls which are kept at the temperature of boiling water (100° C.), and let us further suppose for the sake of simplicity that there is no air in this chamber, so that no heat can be carried about by movable particles of gas. If under these circumstances we put a cold body into the chamber, it will ultimately reach 100°, at which temperature it will remain. This is a statement of the doctrine of temperature equilibrium; but this equilibrium may be of two kinds—for it may either be a statical equilibrium, in virtue of which two bodies at the same temperature cease to radiate to each other, or it may be a dynamical equilibrium, in virtue of which each of these bodies independently radiates heat to its neighbour, receiving back, however, just as much heat as it gives out. In either case the ultimate result will be equality of temperature, and the only difference is with regard to the physical machinery by which this is brought about. In the theory of statical equilibrium the behaviour of two bodies of equal temperature with respect to heat may be compared to that of a man with respect to money who is getting neither richer nor poorer, because he is neither giving away nor receiving any money, whereas in the theory of dynamical or movable equilibrium the comparison is with the man who is getting neither richer nor poorer because he is receiving back just as much money as he is giving out.

Now, we are all of us conversant with frequent examples of individuals of this latter class, but the condition of things in this world is such that we cannot have any permanent example of the former, and similar considerations might convince us that if radiant light and heat be in reality a kind of energy, the theory of a movable or dynamical equilibrium must be much more suitable to such a constitution of things than that of a statical or tensional equilibrium. Historically, however, the question of temperature equilibrium was not decided by considerations regarding energy, our conceptions of which were not then sufficiently advanced to be of much service to those who were engaged in the discussion.

As the subject is one of great theoretical and practical importance, we shall proceed to give a short account of the circumstances attending the origin and development of what is now known familiarly as the *theory of heat exchanges*. About a century ago Prof. Pictet of Geneva made the following experiment:—He took two concave metallic reflectors, and, reversing the ordinary mode of procedure, put ice or a freezing mixture in the focus of the one and a thermometer in that of the other, upon which the temperature of the thermometer was observed to fall. This effect would at once be explained if we could suppose that cold was a substantial entity capable of radiation and reflexion like heat. But it was immediately recognised that such an hypothesis is quite inadmissible, and Prof. Pierre Prevost, also of Geneva, was thus driven to propose for the explanation of this experiment the theory of a movable equilibrium of heat.

It is very evident that such a theory will explain the

[1] Continued from p. 327.